SOLID PARTICLE EROSION OF JUTE FIBRE REINFORCED RED MUD FILLED EPOXY RESIN COMPOSITE

A THSIS SUBMITTED IN PARTIAL FULLFILLMENT OF THE REQUIREMENT FOR THE DEGREE OF

BACHELOR OF TECHNOLOGY
IN
MECHANICAL ENGINEERING

SUBMITTED BY

SAIKAT SINHA (10303006)

BIMAL PATEL (10303011)

DEPARTMENT OF MECHANICAL ENGINEERING
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UNDER YHE GUIDANCE OF DR S.K. ACHARYA

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CERTIFICATE

This is to certify that the thesis entitled "Solid particle erosion of jute fibre reinforced Red-mud filled Epoxy Resin composite" submitted by Saikat Sinha, Roll No. 10303006 and Bimal, Patel Roll No. 10303011 in partial fulfillment of the requirement for the award of Bachelor of Technology Degree in Mechanical Engineering at the National Institute of Technology, Rourkela (Deemed University) is an authentic work carried out under my supervision and guidance.

To the best of my knowledge, the matter embodied in the thesis has not been submitted to any other University/Institute for the award of any Degree or Diplma.

Date

Dr. Samir Kumar Acharya
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CONTENTS

ABSTRACT

Composite material has been used in India for last three years. Indigenous production of unsaturated polyester resin has started in 1962 and of glass fibers in 1965, preparing the foundation for growth of composites in India. Polymer composites are gaining popularity in many industrial applications due to their higher specific strength and module.

In recent years the natural fiber composites have attracted substantial importance as a potential structural material. The attractive features of natural fibers like Jute, Sisal, Coir and banana have been their low cost , light weight ,high specific modulus, renewability and biodegradability. Natural composites reinforced with such natural fibers have thus been a subject of intense study for low strength , low cost application in contrast to the synthetic fiber reinforced composite.

In the present work "**Solid particle erosion of Jute fiber reinforced Red mud filled Epoxy resin Composit**e" tests were performed to calculate the erosion rate of the composites for the different variables. The composites were fabricated using Epoxy resin as polymer, Araldite as hardener, Jute fiber as reinforcement. Single, double and four layer composites were made. They were then experimented in the erosion testing machine. Three variables were kept constant while the other one was varied. It was repeated for all the other variables Graphs were drawn showing the variation with the mass loss.

CHAPTER 1

INTRODUCTION

Composites

1.1 INTRODUCTION

History is often marked by the materials and technology that reflect human capability and understanding. Mainly time scales begin with the Stone age, which led to the Bronze, Iron, Steel, Aluminum, and Alloy ages as improvements in refining, smelting, and science made these more advanced materials possible. In the 1980's the Composite age began, represented at its extremes by the Stealth bomber and the sun powered Solar Challenger.

Progress in the development of advanced composites – from the days of E-glass/phenolic random structures of the early 1940's to the graphite/polyamide composites used in the space shuttle orbiter-is spectacular. The recognition of the potential weight savings that can be achieved by using the advanced composites, which in turn means reduced cost and greater efficiency, was responsible for this growth n the technology of reinforcements, matrices, and fabrication of composites. If the first two decades saw the improvements in the fabrication methods, systematic study of properties and fracture mechanics was at the focal point in the 60's. With the advent of high modulus fibers like carbon/graphite fibers, aramid fibers etc., and the availability of various polymers including the more readily processable, composites are now competing strongly with metals and alloys particularly in the aerospace industry. The importance of composites as engineering materials is reflected by the fact that out of over 1600 engineering materials available in the market today more than 200 are composites.

The Composites technology of a polymeric matrix reinforced with man-made fibers such as glass, Kevlar, carbon etc. has come of age especially with the advances in aerospace applications since 1950's. The developments in composite material after meeting the challenges of aerospace sector have cascaded down for catering to domestic and industrial applications. Composites, the wonder material with light-weight, high strength-to-weight ratio and stiffness properties have come a long way in replacing the conventional materials like metals, woods etc.

Ecological awareness has resulted in a renewed interest in natural materials and issues such as recycleability and environmental safety are becoming increasingly important for the introduction of new composite materials and products. Environmental legislation as well as consumer

demands is all increasing the pressure on manufacturers of materials and end-products to consider the environmental impact of their products at all stages of their life cycle, including recycling and ultimate disposal.

These environmental issues have recently generated considerable interest in the development and of composite materials based on renewable resources such as natural fibers as environmentally friendly and low-cost alternatives for glass fibers and the use of plastics based on renewable resources for the development of true bio-composites.

Currently a large number of interesting applications are emerging and especially the automotive e industry is looking seriously into the use of eco-composites as a way to serve the environment and at the same time save weight and cost.

Over the last thirty years composite materials, plastics and ceramics have been the dominant emerging materials. The volume and number of applications of composite materials have grown steadily, penetrating and conquering new markets relentlessly. Modern composite materials constitute a significant proportion of the engineered materials market ranging from everyday products to sophisticated niche applications.

While composites have already proven their worth as weight-saving materials, the current challenge is to make them cost effective. The efforts to produce economically attractive composite components have resulted in several innovative manufacturing techniques currently being used in the composites industry. It is obvious, especially for composites, that the improvement in manufacturing technology alone is not enough to overcome the cost hurdle. It is essential that there be an integrated effort in design, material, process, tooling, quality assurance, manufacturing, and even program management for composites to become competitive with metals.

Further, the need of composite for lighter construction materials and more seismic resistant structures has placed high emphasis on the use of new and advanced materials that not only decreases dead weight but also absorbs the shock & vibration through tailored microstructures. Composites are now extensively being used for rehabilitation / strengthening of pre-existing

structures that have to be retrofitted to make them seismic resistant, or to repair damage caused by seismic activity.

Unlike conventional materials (e.g., steel), the properties of the composite material can be designed considering the structural aspects. The design of a structural component using composites involves both material and structural design. Composite properties (e.g. stiffness, thermal expansion etc.) can be varied continuously over a broad range of values under the control of the designer. Careful selection of reinforcement type enables finished product characteristics to be tailored to almost any specific engineering requirement.

Whilst the use of composites will be a clear choice in many instances, material selection in others will depend on factors such as working lifetime requirements, number of items to be produced (run length), complexity of product shape, possible savings in assembly costs and on the experience & skills of the designer in tapping the optimum potential of composites. In some instances, best results may be achieved through the use of composites in conjunction with traditional materials.

1.1.1DEFINITIONS OF COMPOSITES

A typical composite material is a system of materials composing of two or more materials (mixed and bonded) on a macroscopic scale.

Generally, a composite material is composed of reinforcement (fibers, particles, flakes, and / or fillers) embedded in a matrix (polymers, metals, or ceramics). The matrix holds the reinforcement to form the desired shape while the reinforcement improves the overall mechanical properties of the matrix. When designed properly, the new combined material exhibits better strength than would each individual material.

As define by Javitz[1] , " Composites are multifunctional material systems that provide characteristic not obtainable from any discrete material. They are cohesive structures made by physically combining two or more compatible materials, different in composition and characteristics and sometimes in form.

Kelly[2] very clearly stresses that the composition should not be regarded simple as a combination of two materials. In the broader significance; the combination has own distinctive properties. In terms of strength or resistance to heat or some other desirable quality, it is better than either of the components alone or radically different from either of them.

Berghezan [3]defines as " the composites are compound materials which different from alloys by the fact that the individual components retain their characteristics but are so incorporated into the composite as to take advantage only of their attributes and not of their shortcomings', in order to obtain an improved material.

Van suchetclan [4]explains composite materials as heterogeneous materials consisting of two or more solid phases which are in intimate contact with each other on a microscopic scale. They can be also considered as homogeneous materials on a microscopic scale in the sense that any portion of it will have the same physical property composite.

1.1.2Why Composite?

Composites are able to meet diverse design requirements with significant weight savings as well as high strength-to weight ratio as compared to conventional materials.

The most important advantages of the use of composite materials is the fact that the material properties of the structural element can be adopted to the profiles of requirement at minimum weight. Apart from this weight saving, the low processing cost and relatively less energy consumptions for making products of composites created more interest in such materials. The following are some of the important advantages of the composite materials.

1. Tensile strength of composites is four to six times greater than that of steel or aluminum.

2. Improved torsional stiffness and impact properties

3. Higher fatigue endurance limit (upto 60% of the ultimate tensile strength).

4. 30-45% lighter than aluminum structures designed to the same functional requirements.

5. Lower embedded energy compared to other structural materials like steel, aluminum etc.

6. Composites are less noisy while in operation and provide lower vibration transmission than metals.

7. Composites are more versatile than metals and can be tailored to meet performance needs and complex design requirements.

8. Long life offers excellent fatigue, impact, environmental resistance and reduced maintenance.

9. Composites enjoy reduced life cycle cost compared to metals.

10. Oxidation, corrosion resistance and fire retardancy of composites are exceptionally good.

11. Improved appearance with smooth surfaces and readily incomparable integral decorative melamine are other characteristics of composites.

1.1.3Characteristics of the composites :

Composites consist of one or more discontinuous phases embedded in a continuous phase. The is continuous phase is usually harder and stronger than the continuous phase and is called the "reinforcement" or "reinforcing material", where as the continuous phase is termed as the "matrix".

The following properties of the composite are to be evaluated for deriving the application of the composite.

1.1.4Density & dimension :

Density of the composite depends on the type and amount of reinforcement. Again, when the composites are treated at the various environmental conditions, there will be a change in volume due to absorption of moisture etc. Hence the measurement of density and the dimensional changes from time to time is to be monitored.

(b) Flexural strength :

Flexural strength is not recommended for generating design data, but it does provide a simple test for quality control.

(c) Measurement of Volume Fraction of the reinforcement :

The dimensional changes were monitored time to time from which the change in volume fraction can be calculated.

(d) Study of fracture surface :

The composites were studied under SEM so that the mode of fracture and the propagation of fracture can be determined.

1.1.5Properties of composite

Some of the important properties of a composite are ;

1. The chemical and strength characteristics of the interface between the fibers and the matrix are particularly important in determining the properties of the composites.

2. The interfacial bond strength has to be sufficient for load to be transferred form the matrix to the fibers if the composite is to stronger than the unreinforced matrix.

3. If we are concerned with the toughness of the composites, the interface must not be so strong that it does not fail, and allow toughening mechanisms such as debonding the fiber pull-out to take place.

4. Volume fraction plays a major role in determining properties. The volume fraction is generally regarded as the single most important parameter influencing the composite properties.

5. Homogeneity is also an important characteristic that determines the extent to which a representative volume of the material may differ in physical and mechanical properties from the average properties of the material.

6. Non informative of the system should be avoided as much as possible because it is reduces those properties that will cover by the weaker part of the composite.

7. The orientation of the reinforcement wit in the matrix affects the isotropy of the system.

1.1.6 Classification of composites

Composite materials can be classified in different ways. Classification based on the geometry of a representative unit of reinforcement is convenient since it is the geometry of the reinforcement which is responsible for the mechanical properties and high temperature performance of the composite. A typical classification is given in

As per the classifications of the composites are basically divided in to two broad classes. They are

Particle-reinforced Composites
Fiber- reinforced Composites

1. Particle-reinforced Composites

These materials utilize larger particles than in dispersion-strengthened composites, and in greater concentrations. The particles strengthen the composite by bearing a significant portion of the load and by restricting the flow of the softer matrix material. Particle fillers are widely used to improve the properties of matrix materials such as to modify the thermal and electrical conductivity's, improve performance at elevated temperature, reduce friction, Increase wear and abrasion resistance, improve machinability, increase surface hardness and reduce shrinkage.

2. Fiber- reinforced Composites

A fiber is characterized by its length being much greater compared to its cross-sectional dimensions. The dimensions of the reinforcement determine its capability of contributing of thief properties to the composites. Fibers are very effective in improving the fracture resistance of the matrix since a reinforcement having a long dimension discourages the growth of incipient cracks normal to the reinforcement that might otherwise lead to failure, Particularly with brittle matrices.

1.2 NATURAL FIBER COMPOSITES

Natural fiber has attracted worldwide attention as potential reinforcement for composites because of their easy availability, easy processability, Low density, Light weight, non abrasivity, and Lower cost and above all eco-friendly characteristics.

Jute Fiber Composite

Jute is an annual plant in the genus Corchorus. The major types grown are generically known as white jute and tossa jute. Jute, grown mainly in India and Bangladesh, is harvested at 2 to 3 months of growth, at which time it is 3-5 meters tall. Jute has a pithy corer, known as jute stick and the blast fibers grow lengthwise around this core. Jute blast fiber is separated from the pith in a process known retting. Retting is accomplished by placing cut jute stalks in ponds for several weeks. Microbial action in the pond softens the jute fiber and weakens the bonds between the individual fibers and the pith. The fiber strands are then manually stripped from the jute stick and hung on racks to dry. Very long fiber strands can be obtained this way. If treated with various oils or conditioners to increase flexibility, the retted jute fiber strands are suitable for manufacturing into textiles.

Most composites made using jute exploit the long fiber strand length. Commercially, both woven and non-woven jute textiles are resin or epoxy-impregnated and molded into fairly complex shapes. In addition, jute textiles are used as overlays over other composites. Jute stick is used for fuel, and in poor areas it is stacked on end, tied into bu8ndles, and used as fences and walls.
There is greater awareness of the need for materials with an expanding population and jute-based composites provide an opportunity to fill this growing need for materials within a cost effective and acceptable environmental framework. Our history using jute in textile applications has limited our expectations of performance, which, ultimately, limits our ability to accept new concepts for improved jute-based composite

1.3 MATRIX MATERIALS

1.3.1 Role of Matrix in a composite

Many materials when they are in a fibrous from exhibit very good strength properties but to achieve these properties the fibers should be bonded by a suitable matrix. The matrix isolates the fibers from one another in order to prevent abrasion and formation of new surface flaws and acts as a bridge to hold the fibers in place. A good matrix should possess ability to deform easily under applied load, transfer the load into the fibers and evenly distribute stress concentrations.

A study of the nature of bonding forces in laminates indicates that upon initial loading there is a tendency for the adhesive bond between the reinforcement and the matrix to be broken. The frictional forces between them account for the high strength properties of the laminates.

2 Components of composite materials

In its most basic form a composite material is one which is composed of at least two elements working together to produce material properties that are different to the properties of those elements on their own. In practice, most composites consist of a bulk material (the 'matrix'), and a reinforcement of some kind, added primarily to increase the strength and stiffness of the matrix.

1.3.3 (a) Bulk Phase

(1) Polymers

A very large number of polymeric materials, both thermo setting and thermo plastic, are used as matrix materials for the materials for the composites. Strong covalent bonds in polymers, if aligned long, the fiber axis of high molecular weight chains, can lead to impressive properties.

(2) Metals

Metallic fibers, such as steel and tungsten, have high strengths and show very consistent properties, unlike ceramic fibers. Since density s very high for these fibers, they are rarely used to reduce weight in a composite. Drawing very thin metallic fibers (less than 100 micron) is also very expensive. Metal Matrix composites (MMC's). Increasingly found in the automotive

industry, these materials use a metal such as aluminum as the matrix, and reinforce it with fibers such as silicon carbide.

Metal matrix composites possess some attractive properties, when compared with organic matrices. These include (i) strength retention at higher temperatures, (ii) higher transverse strength, (iii) better electrical conductivity, (iv) superior thermal conductivity, (v) higher erosion resistance etc. however, the major disadvantage of metal matrix composites is their higher densities and consequent lower specific mechanical properties compared to polymer matrix composites. Another notable difficulty is the high energy requirement for fabrication of such composites.

(3) Ceramics

Ceramic fibers, such as Alumina and SiC (silicon carbide) are advantageous in very high temperature applications, and also where environmental attack is an issue. Since ceramics have poor properties in tension and shear, most applications as reinforcement are in the particulate form (e.g. zinc and calcium phosphates) Ceramic Matrix Composites (CMC's) – used in very high temperature environments, these materials use a ceramic as the matrix and reinforce it with short fibres, or whiskers such as those made from silicon carbide and boron nitride.

1.3.4 (b) Reinforcements

The role of the reinforcement in a composite material is fundamentally one of increasing the mechanical properties of the neat resin system. All of the different fibres used in composites have different properties and so affect the properties of the composites have different properties and so affect the properties of the composite in different ways. For most of the applications, the fibres need to be arranged into some form of sheet, known as a fabric, to make handling possible. Different ways for assembling fibres into sheets and the variety of fibre orientations possible toto achieve different characteristics.

(c) Interface

It has characteristics that are not depicted by any of the component in isolation. The interface is a bounding surface or zone where a discontinuity occurs, whether physical, mechanical, chemical etc. The matrix material must "wet" the fiber. Coupling agents are frequently used to improve wetability . Well "wetted" fibers increase the interface surface area. To obtain desirable properties in a composite, the applied load should be effectively transferred from the matrix to the fibers via the interface. This means that the interface must be large and exhibit strong adhesion between fibers and matrix. Failure at the interface (called debonding) may or may not be desirable.

In the course of the experiment we have fabricated different layers of composites (single, double, four) using raw materials like Epoxy resin, Jute fiber, Red mud and Araldite. The Jute fiber was first alkali treated for 4 Hours. The composite was then fabricated The composites were then experimented in the erosion testing machine to find out the mass loss for different variables (pressure, temperature, stand off distances and sand particle size)

In the second chapter a literature survey on the natural composites and mainly jute fiber was done. This chapter contains an outline review of the existing literature in the area of jute fiber reinforced jute material. The major fulfillment and results reported in the literature are highlighted.

In the third chapter the main experimental set up and procedure was explained. Different layers of the composites were made in single, double and four layers. The experimented was performed using pressure, temperature, stand off distances, erodent size as the variables. At the end, graphs were drawn to show the variation of the variable with erosion rate.

CHAPTER 2

LITERATURE-REVIEW

2.1 LITERATURE REVIEW

Natural fiber composites combine good mechanical properties with a low specific mass (approximately 1.2± 1.5 g/cm^3). But their high level of moisture absorption, poor wetability and an inadequate level of adhesion between untreated fibers and a non-polar polymer matrix lead to debonding with age. On the other hand, the tensile strength of natural fibers is only 20±50% of that of E-glass fibers. The Young's modulus, for flax for instance, at approximately 28GPa is much closer to the characteristic values of E-glass fibers. Unfortunately, all mechanical and other physical properties of natural fibers are influenced by their growing conditions, fiber-processing technique and, as for other fiber types, by the conditions, fiber-processing technique and, as for other fiber types, by the fineness of the fiber and sample test-length. Although, as with most of the other plant-based natural fibers, cellulose forms the main structural components of jute, the non-cellulosic components e.g., lignin and hemicellulose, also plays an important part in determining the characteristic properties of the fibers. Jute hemicellulose, which is thought to consist principally of xylan, polyuronide and hexosan, has been shown to be very sensitive to the action of caustic soda, which exerts only a slight effect on lignin or cellulose

Wacker G.et [5].al studied the influence of fiber content on the dynamic modulous of jute/epoxy composites with untreated and alkali treated jute fibers. Their results showed slower damage growth in the composite with NaOh treated fibers.

Dipa ray,B K Sarkar ,s das ,ak rana [6] studied Vinyl –resin –matrix reinforced with untreated and 5% NaOh treated jute fibers for 4 and 8 hrs with different fiber loading subjected to dynamic mechanical and thermal analysis to determine their dynamic properties as a function of temperature. Their results shows that for all the composites the storage modulous decreases with increase in temperature with a significant fall in the temperature range 110-170.

Mohanty [7] examined the potential of jute fiber as an alternative to traditional man made fibers in fiber reinforced plastics.

Gassan ,Jochen,Bledzki [8]tried to improve the mechanical properties of natural fiber by the use of an NaOh treatment processes.they found the improvement in the dynamic modulous of the composite as a result of the use of treated fibers.

Several authors for composite application having good bonding between fiber and the resin matrix treated jute with alkali a processes known as mercerization properties.

Rana[9] gave a comparison of the jute fiber as a reinforced material compared to glass fiber and conclude that this natural fiber possesses some draw backs and needs chemical modification for improvement in properties

Natural fiber composites have been a subject of interest for last few decades, for their attractive features. Several authors for composite applications having good bonding between fiber and the resin matrix treated jute with alkali a processes known as mercerization properties.

Jute is one of the most common agro-fibers which obtain high tensile modulus and low elongation at break. If the low density (1.4 g/cm3) of this fiber is taken into consideration, then its specific stiffness and strength are comparable to those of glass fiber There are many reports about the use of jute as reinforcing fibers for thermosets. Previous works suggest that jute can also be used as reinforcing fiber for polypropylene (PP) and polyethylene.

Rana et al.[9] studied the DTM behavior of short jute-fiber-reinforced polypropylene composites and observed the effect of compatibilser on the duynamic properties of the comnpostes. They observed that the loss moduls increased and higher temperatures with the increase of the fiber loading I the composites. The efficiency of the compatibilised system was more prominent at higher tempatrature and at higher fiber loading. They reported a tiny hump at a temperature higher than the glass transition temperature (Tg) and explained it as movement towards the Tg of the dry cellulose (200^0 C)

gassan, Jochen, Bledzki, Andrzej K[8] tried to improve the mechanical properties of natural fiber tossa jute fibers by the use of and Na OH treatment processes. They found the improvement in the dynamic modulus of the composite as a result of the use of treated fibers.

Mohanty et al examined the potential of jute fiber as an alternative reinforcement to traditional man-made fibers in fiber reinforced plastics.

Mwaikambo, Leonard Y.[10] tried to use the plant fibers as potential for polymer reinforcement as they are rich in cellulose and they are cheap, easily renewable source of fibers. Hemp, sisal, jute and kapok fibers were subjected to alkalization by using sodium hydroxide. The thermal characterstics, crystalinity index, reactivity, and surface morphology of untreated and chemically modified fibers have been studied.

Mukherjee a ,ganguly p.k[11]. gave a comparision of the jute fiber as a reinforced material compared to glass fiber and conclude that this natural fiber possesses some draw back and needs chemical modification for improvement in properties.

Ray, Dipa, Sarkar, B.K. Basak, R.K.: Rana, A.K.) [12]studied there thermal behavior of vinyl ester resin matrix composite reinforced with jute fibers treated for 2,4,6, and 8hr with 5% NaOH. The moisture description peak shifted to a higher temperature, form 37 to 58.3^0C, for all the treated- fiber composites because of improved wetting of the fibers by the resin and stronger bonding at the interface. The degradation temperature of the vinyl ester resin in the composites was lowered to 410.3^0C.

CHAPTER 3

MATERIALS AND METHODS

Sample Preparation

Experimentation

3.1 PREPARATION OF COMPOSITES

3.1.1 **Materials and methods**

Raw Materials

Raw materials used in this experiment are listed below

Jute Mats

Red mud

Epoxy Resin

Hardener

Alkali

3.1.2.Jute mats

As pointed earlier that, natural vegetable fibers have attracted worldwide attentions as a potential reinforcement for composites because of their easy availability as a renewable resource, easy precessability, low density, light weight, non abrasivity, low cost and above all for their biofriendly characteristics. Jute is one of such high performance bicomposite. In this experiment jute has been taken as reinforcement.

Epoxy Resin:

Epoxy resin (Araldite LY 556) made by CIBA GUGYE Limited, having the following outstanding properties has been used.

Excellent adhesion to different materials

Great strength, toughness resistance

Excellent resistance to chemical attack and to moisture

Outstanding electrical insulating properties

Absence of volatile on curing

Negligible shrinkage

Hardener

In the present work Hardener (araldite) HY 951 is used. This has a viscosity of 10-20 poise at 25^{o}C.

3.1.3 Dry analysis of Red mud Red Mud :

Production of alumina from Bauxite by the Bayer's process is associated with the generation of red mud as the major waste material. Depending upon the quality of bauxite the quantity of red mud generated varies from 55-65% of the bauxite processed. This waste material has been accumulating at an increasing rate throughout the world . In the world nearly 30million tons of red mud is produced annually. This figure is calculate on the basis that two tons of alumina are used to produce one ton of aluminum and that 58% of alumina and 42% of red mud comes out from one ton of bauxite approximately. In India, at present, aluminum production per year is 0.46 million ton of red mud generation in the country. The disposal / utilization of red mud has been an acute problem and a clear-cut solution is not available till date. Different avenues of red mud utilization are more or less known but none of them have so far proved to be economically viable or commercially feasible. However a survey literature on utilization of red mud published so far has revealed that use of red mud is restricted only for recovery of metal values, recovery of alkali, use of catalyst, as building material in paints and pigments etc. as per the knowledge of the investigator, use of red mud as a reinforcement material for preparation of PMCs has not been reported so far.

Red mud, for the present investigation was collected from Damonjori plant of NALCO, Damanjori , Koraput, dust was prepared manually. The size of dust was measured by sheave. Then as per sheave analysis average size of the dust was 150 micro mm. The results of the dry analysis of red mud are given in table

TABLE 3.1

2.

COMPONENT	%age	COMPONENT	%age
Al_2O_3	15.00	Fe_2O_3	62.78
TiO_2	3.77	SiO_2	0.0097
Na_2O	4.88	CaO	0.23
P_2O_5	0.67	V_2O_5	0.379
Zn	0.018	Ga_2O_3	0.0097
Mn	1.1	Mg	0.056
Organic C	0.88		

3.1.4 Preparation of the Composite

Following procedure has been adopted for the preparation of the composite. The jute mats were cut from the gunny bags used for packaging in agricultural sectors. The jute bags are first washed with plane water and after drying particular shape of pieces are cut from the whole bag. The average diameter of the jute fiber in the mats are of about 1.5 mm with inter-fiber spacing of about 2mm.

Alkali Treatment

The jute mats were cut to 25cm x 30cm of length and were soaked in a 5% NaOH solution at room temperature maintaining a liquor ratio of 15:1. The fibers were kept immersed in the alkali solution for 4 hrs. The fibers were then washed several times with fresh water to remove any NaOH sticking to the fiber surface, neutralized with dilute acetic acid and finally washed again with distilled water. Final pH maintained was 7. The fibers were then dried at room temperature for 48 hrs followed by oven drying at 100 C for 6 hrs.

3.1.5 Sample Preparation.

The jute / polymer composite containing the raw and the alkali treated jute ,mats wear fabricated in the from of rectangular sheets. Epoxy resin (araldite), hardener and red mud were mixed in appropriate proportion at room temperature. While mixing, care was taken to avoid the formation of bubbles in the resin system. On addition of the hardener, resin and red mud started becoming more viscous. Proper stirring should continue until the mixture lost its ability to flow. This is known as the gel point. To fabricate the composition, two glass plates were taken. For easy point removal of the composition hot wax was spread uniformly over the glass plates. First the mixture of araldite, hardener and red mud was spread over the wax surface followed by lying up of a piece of jute mat (in the shape of rectangle). Again another layer of mixture was spread . In the same way composition were prepared with different layer of jute mat (i.e with single, double and triple layer) for both treated and untreated jute mats. Care was taken to avoid presence of any air bubbles in between the layers. After preparation the samples wear kept for 72 hrs for proper hardening .After curing the samples were cut from rectangular slabs to sizes fro the experimental work. Dimension (length, breadth and thickness) and also weight of each specimen were measured prior to various treatments. Each sample was assigned a number latter for its easy recognition.

3.2 EROSION TEST

3.2.1 1EXPERIMENTAL SET-UP

Erosion is usually simulated in the laboratory by one of two methods. The ‘sand blast’ method, where particles are carried in an air flow and impacted onto a stationary target, and the ‘whirling arm’ method, where the target is spun through a chamber of falling particles.

In the present investigation, a self- made erosion apparatus of the “sand blast” type was used. It was designed and then was fabricated in our laboratory. It is capable of creating highly reproducible erosive situation over a wide range of particles sizes, velocities, particles fluxes and incident angles, in order to generate quantitative data on materials and study the mechanism of damaged.

Erosion is an important wear mechanism in industrial applications. Despite the existence of ASTM and DIN standard methods, everyone has their own way of doing erosion tests. ASTM G-76 [74] "Standard Practice for Conducting Erosion Tests by Solid Particle Impingement" in fact acknowledges that one single laboratory test may not be sufficient to evaluate expected service performance. Actual erosion service can involve a range of particle sizes, velocities, attack angles & environments, all of which influence erosion rate. The test performed in this work more or less confirms to the prescribed ASTM G76 standards.

Key parameters to define and control in an erosion test are as follows:

1. Particle velocity. (Not the same as the air velocity, but is often assumed to be)
2. Particle mass flow rate
3. Nozzle wear
4. Particle spread from nozzle
5. Size and shape of particle
6. Angle of impact of the particles

One particular feature of the ASTM G76 method is the fact that the very small jet diameter (1.5-mm) results in the particles "drilling" into the surface. The standard states that the depth of penetration should not exceed 1 mm. This is a deep hole in any surface and in fact the deeper the

penetration, the more the physical state of the erosion jet will change (due to interaction of the particles hitting the surface and rebounding).

Fig 3.1

Fig 3.2

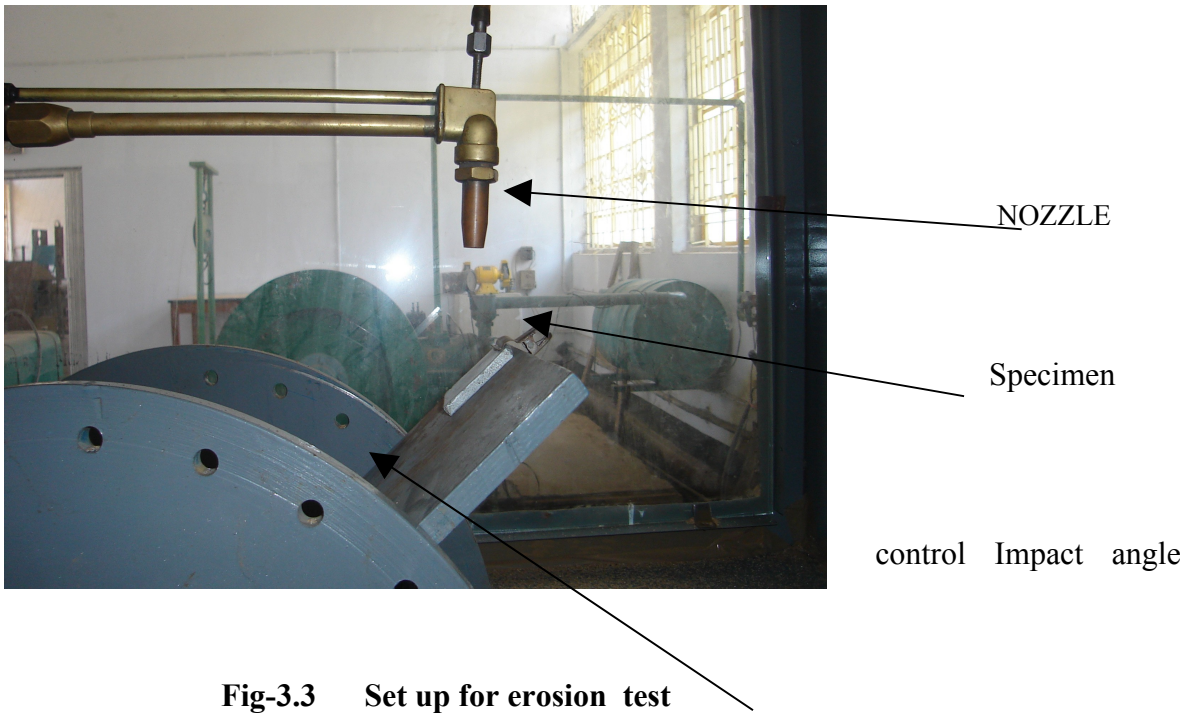

Fig-3.3 Set up for erosion test

Description:

The jet erosion rig developed for this work uses a larger nozzle of 3.0 mm bore and 300 mm long. This means that operating pressures are very much lower. The nozzle used for the present investigation is made of brass. The advantage of using brass is that internal surface finish can be carefully control and the cost of replacement nozzles when necessary is very low. The larger.nozzle diameter results in a wider spread of particles, which is therefore more suited to erosion testing on coatings as well as solid material. There is less of a tendency to "drill" holes in the surface, in addition, there is little influence of rebounding of particles on the impinging jet, resulting in a better controlled erosion process. The larger nozzle size also permits a wider range of particle types to be used in the course of testing, allowing better simulations of real erosion conditions. The mass flow rate was measured by conventional method. Particles are fed from a simple hopper under gravity into the groove.

Key features of the designed setup:

Vertical traverse for the nozzle: provides variable nozzle to target standoff distance, which influences the size of the eroded area.

Different sizes of nozzle may be accommodated: provides ability to change the particle dimensions and the velocity range.

Large test chamber with sample mount (typical sample size 50 mm x 25 mm) that can be angled to the flow direction: by tilting the sample stage, the angle of impact of the particles can be changed and this will influence the erosion process.

Major variables during the erosion test:

The major variables, which were adjusted during the erosion test, are

1. Particle velocity

2. Size and shape of particle

3. Angle of impact of the particles

The erosion test conditions are shown in Table-3.1

TABLE-3.1

Experimental Parameters	
Erodent	Silicon Carbide
Erodent size(mess no.)	80 , 100
Erodent shape	Angular
Impact angles	15^0,30^0,45^0 and 90^0
Stand off distance (mm)	60,80 and 120
Pressure (bar)	6,7 and 8
Test temperature	Room Temperature

3.3 EXPERIMENTATIONS AND OBSERVATIONS

SET-1

1. **CHANGING PARAMETER**--------ANGLE.

2. **CONSTANT PARAMETERS**

   Pressure----------4 Bars.

   Stand Off Distance --------10cm.

   Erodent Size----------400 Microns.

3. **Time in Seconds.**
4. **Mass in Grams**

1. ANGLE=30º

3.2 SINGLE LAYER

Sl no	Time	Initial mass	Final mass	Mass loss
1	10	3.790	3.780	0.010
2	20	3.790	3.770	0.020
3	30	3.790	3.760	0.030

3.3 DOUBLE LAYER

Sl no	Time	Initial mass	Final mass	Mass loss
1	10	3.800	3.790	0.010
2	20	3.800	3.780	0.020
3	30	3.800	3.760	0.040

3.3 FOUR LAYER

Sl no	Time	Initial mass	Final mass	Mass loss
1	10	10.790	10.780	0.010
2	20	10.790	10.770	0.020
3	30	10.790	10.760	0.040

ANGLE=45º

3.4 SINGLE LAYER

Sl no	Time	Initial mass	Final mass	Mass loss
1	10	3.800	3.790	0.010
2	20	3.800	3.780	0.020
3	30	3.800	3.760	0.040

3.5 DOUBLE LAYER

Sl no	Time	Initial mass	Final mass	Mass loss
1	10	6.210	6.200	0.010
2	20	6.210	6.180	0.030
3	30	6.210	6.160	0.050

3.5 FOUR LAYER

Sl no	Time	Initial mass	Final mass	Mass loss
1	10	10.670	10.660	0.010
2	20	10.670	10.650	0.020
3	30	10.670	10.630	0.040

ANGLE=60º

3.6 SINGLE LAYER

Sl no	Time	Initial mass	Final mass	Mass loss
1	10	3.940	3.930	0.01
2	20	3.940	3.910	0.03
3	30	3.940	3.890	0.05

3.7 DOUBLE LAYER

Sl no	Time	Initial mass	Final mass	Mass loss
1	10	7.020	7.010	0.010
2	20	7.020	6.080	0.040
3	30	7.020	6.060	0.060

3.8 FOUR LAYER

Sl no	Time	Initial mass	Final mass	Mass loss
1	10	10.420	10.410	0.010
2	20	10.420	10.390	0.020
3	30	10.420	10.370	0.050

2. **ANGLE=90º**

3.8 SINGLE LAYER

Sl no	Time	Initial mass	Final mass	Mass loss
1	10	3.840	3.830	0.010
2	20	3.840	3.820	0.020
3	30	3.840	3.800	0.040

3.9 DOUBLE LAYER

Sl no	Time	Initial mass	Final mass	Mass loss
1	10	7.200	7.190	0.010
2	20	7.200	7.180	0.020
3	30	7.200	7.170	0.030

3.10 FOUR LAYER

Sl no	Time	Initial mass	Final mass	Mass loss
1	10	9.480	9.470	0.010
2	20	9.480	9.460	0.020
3	30	9.480	9.440	0.040

SET-2

1. **CHANGING PARAMETER**--------PRESSURE

2. **CONSTANT PARAMETERS**

   Angle----------60º.

   Stand Off Distance --------10cm.

   Erodent Size----------400 Microns.

3. **Time in Seconds.**
4. **Mass in Grams.**

PRESSURE = 4 BARS

3.11 SINGLE LAYER

Sl no	Time	Initial mass	Final mass	Mass loss
1	10	3.940	3.930	0.01
2	20	3.940	3.920	0.02
3	30	3.940	3.890	0.05

3.12 DOUBLE LAYER

Sl no	Time	Initial mass	Final mass	Mass loss
1	10	7.020	7.010	0.010
2	20	7.020	6.080	0.040
3	30	7.020	6.060	0.060

3.13 FOUR LAYER

Sl no	Time	Initial mass	Final mass	Mass loss
1	10	10.890	10.880	0.010
2	20	10.890	10.870	0.020
3	30	10.890	10.850	0.040

PRESSURE = 6 BARS

3.14 SINGLE LAYER

SL NO.	TIME	Initial mass	Final mass	Mass loss
1	10	3.840	3.830	0.010
2	20	3.840	3.810	0.030
3	30	3.840	3.790	0.050

3.15 DOUBLE LAYER

Sl no	Time	Initial mass	Final mass	Mass loss
1	10	5.610	5.600	0.010
2	20	5.610	5.560	0.050
3	30	5.610	5.510	0.100

3.16 FOUR LAYER

Sl no	Time	Initial mass	Final mass	Mass loss
1	10	11.110	11.100	0.010
2	20	11.110	11.080	0.030
3	30	11.110	11.050	0.060

PRESSURE = 7 BARS

3.17 SINGLE LAYER

SL NO.	TIME	Initial mass	Final mass	Mass loss
1	10	2.120	2.110	0.010
2	20	2.120	2.100	0.020
3	30	2.120	2.090	0.030

3.18 DOUBLE LAYER

Sl no	Time	Initial mass	Final mass	Mass loss
1	10	7.970	7.960	0.010
2	20	7.970	7.950	0.20
3	30	7.970	7.930	0.40

3.19 FOUR LAYER

Sl no	Time	Initial mass	Final mass	Mass loss
1	10	9.020	9.010	0.010
2	20	9.020	9.00	0.20
3	30	9.020	8.970	0.50

SET-3

1. **CHANGING PARAMETER**--------Stand Off Distance.

2. **CONSTANT PARAMETERS**

   Angle----------60º.

   Pressure ----------10Bars.

   Erodent Size----------400 Microns.

3. **Time in Seconds.**
4. **Mass in Grams**.

10 cm

3.20 SINGLE LAYER

SL NO.	TIME	Initial mass	Final mass	Mass loss
1	10	3.940	3.930	0.010
2	20	3.940	3.910	0.03
3	30	3.940	3.89	0.05

3.21 DOUBLE LAYER

Sl no	Time	Initial mass	Final mass	Mass loss
1	10	7.020	7.010	0.010
2	20	7.020	6.080	0.040
3	30	7.020	6.060	0.060

3.22 FOUR LAYER

Sl no	Time	Initial mass	Final mass	Mass loss
1	10	10.890	10.880	0.010
2	20	10.890	10.870	0.200
3	30	10.890	10.850	0.040

15 cm

3.23 SINGLE LAYER

SL NO.	TIME	Initial mass	Final mass	Mass loss
1	10	2.100	2.090	0.010
2	20	2.100	2.080	0.020
3	30	2.100	2.070	0.030

3.24 DOUBLE LAYER

Sl no	Time	Initial mass	Final mass	Mass loss
1	10	7.860	7.840	0.020
2	20	7.860	7.830	0.030
3	30	7.860	7.820	0.040

3.25 FOUR LAYER

Sl no	Time	Initial mass	Final mass	Mass loss
1	10	10.570	10.560	0.010
2	20	10.570	10550	0.020
3	30	10.570	10540	0.030

SET-4

1. **CHANGING PARAMETER**--------ERODENT SIZE.

2. **CONSTANT PARAMETERS**

   Angle----------60º.

   Pressure ----------4 Bars.

   Stand Off Distance----------10 cm.

3. **Time in Seconds.**
4. **Mass in Grams**.

400 MICRONS

3.26 SINGLE LAYER

Sl no	Time	Initial mass	Final mass	Mass loss
1	10	3.940	3.930	0.01
2	20	3.940	3.910	0.03
3	30	3.940	3.890	0.05

3.27 DOUBLE LAYER

Sl no	Time	Initial mass	Final mass	Mass loss
1	10	7.020	7.010	0.010
2	20	7.020	6.080	0.040
3	30	7.020	6.060	0.060

3.28 FOUR LAYER

Sl no	Time	Initial mass	Final mass	Mass loss
1	10	9.560	9.550	0.010
2	20	9.560	9.530	0.030
3	30	9.560	9.510	0.050

200 MICRONS

3.29SINGLE LAYER

Sl no	Time	Initial mass	Final mass	Mass loss
1	10	3.850	3.840	0.010
2	20	3.850	3.830	0.020
3	30	3.850	3.820	0.030

3.30 DOUBLE LAYER

Sl no	Time	Initial mass	Final mass	Mass loss
1	10	7.240	7.230	0.010
2	20	7.240	7.220	0.020
3	30	7.240	7.200	0.040

3.31 FOUR LAYER

Sl no	Time	Initial mass	Final mass	Mass loss
1	10	9.540	9.530	0.010
2	20	9.540	9.520	0.020
3	30	9.540	9.510	0.030

chapter 4

RESULTS ,DISCUSSIONAND CONCLUSION

4.1 RESULTS AND DISCUSSION

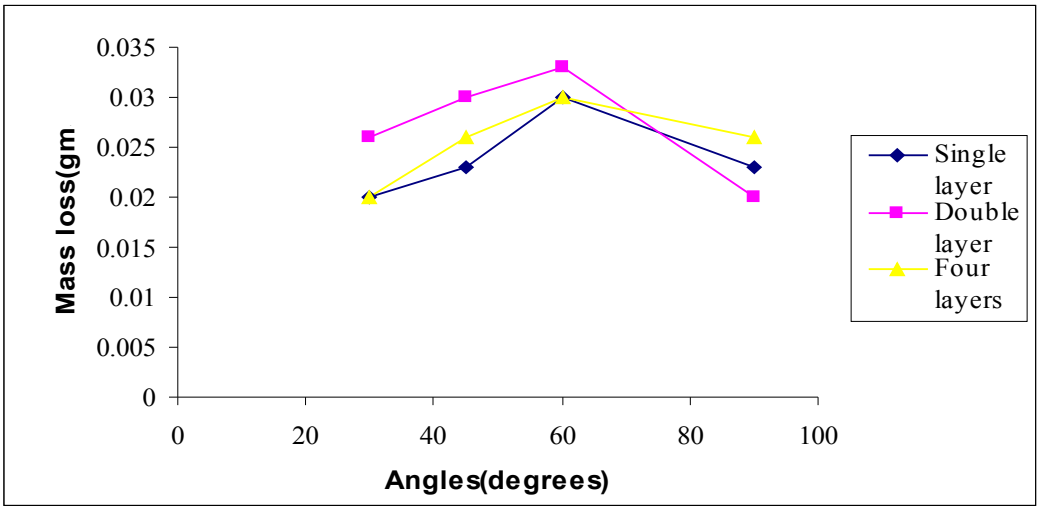

FIG 3.4

Fig 3.1 shows the variation of mass loss versus angles for the composite. From the graph it is visible that mass loss increases with increase in angle till 60° and then it decreases. The maximum mass loss was obtained in 60° for all the three layers of composite.

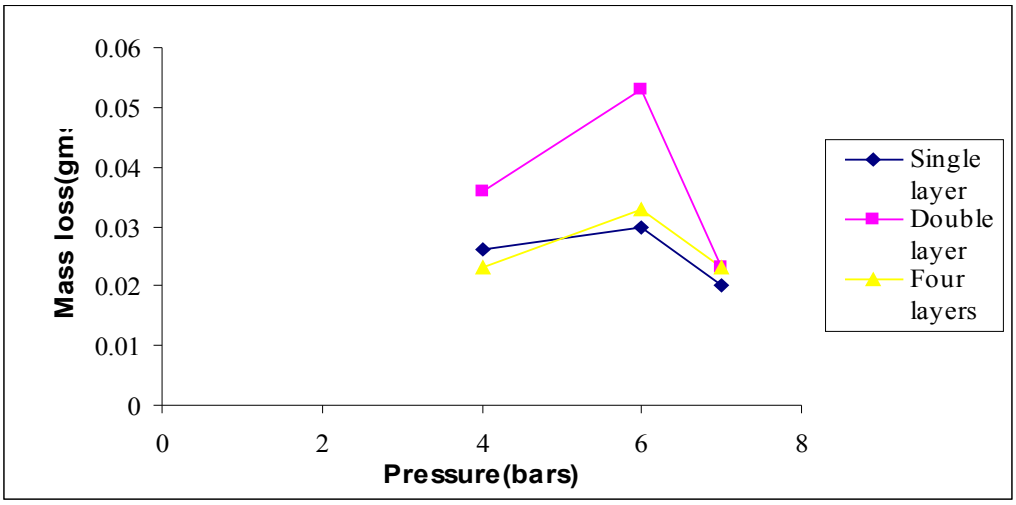

FIG 3.5

Fig 3.2 shows the variation of mass loss versus angles for the composite. From the graph it is visible that mass loss increases with increase in pressure from 4 bars to 6 bars and then it decreases with increase to 7 bars. The reason for this drop may be due to decrease in mass flow rate of erodent particles with increase in air flow rate.

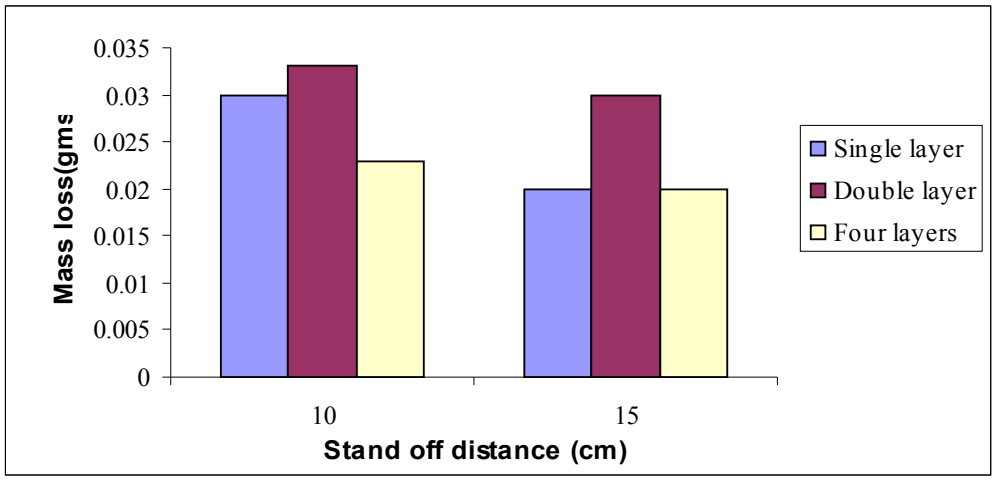

FIG 3.6

Fig 3.3 shows the variation of mass loss versus stand off distance for the composite. From the graph it is visible that mass loss decreases with increase in stand off distance.

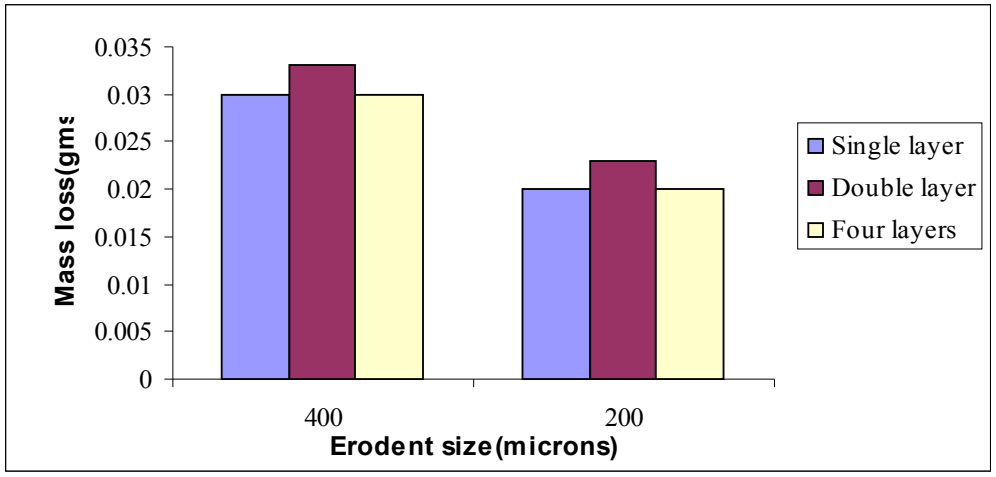

FIG 3.7

Fig 3.4 shows the variation of mass loss versus erodent size for the composite. From the graph it is visible that as the size of the erodent gets smaller the mass loss decreases for all the three layers of the composites.

4.2 CONCLUSIONs

1. Jute fiber reinforced redmud filled PMC can be successfully fabricated .
2. The erosion rate behavior is different for oblique and at normal impact angles.
3. The results indicate that angle of impact is the most important parameter during erosion followed by erodent size.
4. Maximum erosion rate is obtained at pressure of 7 bar.
5. From the aesthetic point of view the fabricated composite promise a wide use in making doors,window,panels,floor tiles etc,

4.2.1 SCOPE FOR FUTURE WORK

In the present investigation 10 % red mud has been used as the interface material but there is a scope to further increase the percentage of red mud in the composite. In the present case sand particles of 200 and 400 microns were used. Experiments can also be performed for other mesh size of erodent. For preparation of the composite other techniques like injection molding can be tried.

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